ITC Study Guide
2008 / 2009 / 2010

Master of Science Degree course and Postgraduate Diploma course in Geoinformatics

Contents

Course codes: C08-GFM-MSc-01
C08-GFM-PG-01

Geoinformatics

Geographic and earth sciences rely increasingly on digital spatial data acquired from remotely sensed images, analysed through geographical information systems and visualised on the computer screen or on paper. The technologies supporting the processes of acquisition, analysis, visualisation and dissemination of spatial data form the core of Geoinformatics. Technological skills alone, however, are not sufficient for organisations involved in the production and management of geo-information. To optimise the use of technology, additional capabilities must be available, such as a thorough understanding of efficient data collection, the structuring of spatial databases and data output by visualisation techniques, as well as a sound organisational infrastructure for the management of and access to the data. Organisations must be able to keep pace with development in electronic data dissemination.

Detailed objectives of the MSc and Postgraduate course

MSc and PGD objectives

On completion of the course, participants should be able to:

- analyse a problem encountered in professional geoinformatics practice and develop an appropriate method to study and/or solve the problem;
- select and possibly develop appropriate methods for geospatial framework data collection and processing;
- use a programming language;
- use GI science and earth observation technology to generate, integrate, analyse and visualise spatial data;
- understand the principles of databases and data models and to use database query languages.

Additional MSc objectives

- Apply research skills to formulate and carry out independent research in the general field of geoinformatics, possibly as part of a multi-disciplinary research and development project.
- Communicate and defend findings of research work.

Organisation and staff of the Geoinformatics courses

Course Director and Course co-ordinators		
	Room	Phone
G.C. Huurneman MSc; GFM Course Director	2-009	216
Ms Dr.Ir. W. Bijker; Course co-ordinator of the Master of Science Degree course	2-040	203
Dr. Ir. R.L.G. Lemmens; Course co-ordinator of the Master Degree course	1-064	529
A.M. Mank; Course co-ordinator of the Diploma course	1-043	459

Course secretariat GFM/LA/UPM		
	Room	Phone
Ms J.M. Mol; course secretary Land Administration (LA) courses	2-105	480
Ms D.E. Scholten; course secretary GFM MSc, PG and Diploma courses	2-105	334
Ms L.J.C. Windig; course secretary GFM Master course and UPM courses	2-105	464

Master of Science Degree Course and Postgraduate Diploma course in Geoinformatics

Duration of the module		Module	Co-ordinating staff member	
		MSc, PG and Master modules		Modules 1-4: **Programming Skills Part 1** Coordinator: Dr. O. Huisman
Module 1:	29-09-08/17-10-08	Introduction and Principles of Databases	Dr. Ir. R.A. de By	
Module 2:	20-10-08/07-11-08	Principles of Remote Sensing	J.P.G. Bakx MSc	
Module 3:	10-11-08/28-11-08	Principles of Geographic Information Systems	Dr. C.P.J.M. van Elzakker	
Module 4:	01-12-08/19-12-08	Mathematics and Programming	Prof. Dr.Ir. M.G. Vosselman	
		MSc and PG modules		Modules 5-10: **Programming Skills Part 2** Coordinator: Dr. O. Huisman
Module 5:	05-01-09/23-01-09	Principles of Spatial Data quality	Dr. N. Hamm	
Module 6:	26-01-09/13-02-09	Base Data Acquisition	Dr. K. Tempfli	
Module 7:	16-02-09/06-03-09	Geodata modelling and processing	Dr. J. Morales	
Module 8:	09-03-09/27-03-09	Visualization and dissemination of geodata	Ms Dr. C. A. Blok	
Module 9:	30-03-09/17-04-09	Image processing	Dr. V.A. Tolpekin	
Module 10:	20-04-09/08-05-09	Web technology for GIS and mapping and Programming	Dr. Ir. R.L. G. Lemmens	
Catch-up week:	11-05-09/15-05-09			
		Postgraduate Diploma part		
Module 11:	18-05-09/05-06-09	Final assignment	Dr. M. Rutzinger	
		MSc research part		
Module 11:	18-05-09/05-06-09	Research skills	Dr. D.G. Rossiter	
Module 12:	08-06-09/26-06-09	Advanced topic	Various	
Module 13:	29-06-09/17-07-09	Advanced topic	Various	
Module 14:	20-07-09/07-08-09	Research project + proposal writing	Various	
Module 15:	10-08-09/28-08-09	Research project + proposal writing	Various	
Catch-up week:	*31*-08-09/04-09-09			
Module 16-23:	07-09-09/26-02-10	Thesis	Ms Dr. W. Bijker	

Master of Science, Postgraduate and Master part

Introduction and Principles of Databases			
Module: 1		Co-ordinating staff: Dr.Ir. R. A. de By	
Start:	29-09-2008		
End:	17-10-2008		
Level: M, MSc, PG			M08-GFM-160

Introduction
This module introduces the notion of database and data manipulation. We focus here on thematic (also known as attribute) databases, the relational data model, and queries in the query language SQL. Database engineering is an important tool for any type of information management. The techniques learnt in this module will be useful throughout the course, and indeed later in professional life.

Contents
The module covers the following topics:
- What purposes do databases serve?
- Database Management Systems.
- The relational data model.
- Set theory and mathematical logic as a foundation for database querying.
- Database querying using SQL.
- Database maintenance.
- Introduction to database design.

Objectives
Main objective: To learn how a database management system works, what stored tables and queries are, and how to define queries in the standard language SQL. Applying all that knowledge to improve an existing database, allowing us to extract information that was originally impossible to extract. Also, the first aspects of database design.

Upon completion of this module student should be able to:
- Explain the fundamentals of the relational data model,
- Formulate simple queries in mathematics,
- Define, execute and verify SQL queries against an existing relational database,
- Improve a badly designed database, and
- Database design: UML class diagrams.

Prerequisites
Basic computer handling skills, some familiarity with Windows software, secondary school discrete mathematics, ability to explore new software and new data sets, group collaboration.

Recommended Knowledge
Basic computer skills, basic mathematics.

Hardware and Software Requirements
Computer cluster. MS Access, MS Excel, MS Word.

Teaching Materials
Principles of Databases, LA/GFM Course Reader, Reader Exercises Databases. Various.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
36	38	0	30	0	16	10

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

In the third week, students will carry out an assignment in groups of three to five students. The work consists of re-organizing a database through queries, and preparing the answers to a number of given data analysis problems. The work is concluded with a small report and a finalizing discussion with the supervisors. The group effort is given a mark between 10 and 100; it will be the first full module mark for each student. In exceptional cases, students may be taken apart for a separate, individual assessment.

Principles of Remote Sensing			
Module: 2		Co-ordinating staff: J.P.G. Bakx M.Sc.	
Start:	20-10-2008		
End:	07-11-2008		
Level: M, MSc, PG			M08-GFM-161

Introduction
This module introduces the principal concepts and techniques remote sensing. The module consist of lectures explaining the theory and focusing on the concepts, and practical's aiming at illustrating the lectures and developing hands-on skills in using (mostly software) tools, carrying out sequential data processing steps for solving typical application problems. The concepts and techniques introduced in the module will be further used and developed during subsequent modules.

Contents
The module covers the following topics:
- The electromagnetic spectrum.
- Sensors and platforms.
- Radiometric aspects of remotely sensed data.
- Geometric aspects of remotely sensed data.
- Aerial photography.
- Image enhancement and visualization.
- Image interpretation and classification.

The module contains the following GFM specific topics:
- Radar;
- Laser scanning.

Objectives
Main objective. To learn how to generate information about the Earth from remote sensing data. At the end of the core modules participants must be able to:
- Explain the principles and use the vocabulary of RS;
- Describe the physical background of remote sensing and compare the main platforms and sensor systems;
- Explain the main digital image processing procedures;
- Describe the common methods of image analysis;
- Perform basic image processing techniques;
- Carry out a visual interpretation of an AP stereo pair and a satellite image;
- Apply appropriate RS methods for problem solving;
- Understand the capabilities, uses and limitations of RS in their field of application;
- Design and carry out sequential data processing steps for solving a typical application problem;
- Evaluate the results of data processing.

Prerequisites
Not applicable.

Recommended Knowledge
Basic computer skills, basic mathematics, stereo vision.

Hardware and Software Requirements
PC; Image Processing Software (ERDAS Imagine) and GIS software (ArcGIS).

Teaching Materials

- Principles of Remote Sensing, ITC Educational Textbook.
- Reader Exercises RS.
- Handouts of lectures.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
34	36	4	8	0	28	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Written closed book exam on (parts of) the ITC RS textbook.

Note:

Examination on this core module contents is based upon the generic topics and will have ITC wide coordination. A precise list of compulsory topics and Textbook paragraphs will be distributed.

Principles of Geographic Information Systems			
Module: 3		Co-ordinating staff: Dr. C.P.J.M. van Elzakker	
Start:	10-11-2008		
End:	28-11-2008		
Level: M, MSc, PG			M08-GFM-162

Introduction
This module introduces the principal concepts and techniques of geographic information systems (GIS). The module consists of two interrelated parts: a theoretical one that focuses on the concepts and a practical one that aims at developing hands-on skills in using (mostly software) tools. The concepts and techniques introduced in these modules will be further enhanced during subsequent modules of the course.

Contents
The module covers the following topics:
- Introduction to GIS.
- Geographic information and spatial data types.
- Data processing systems.
- Determining and mapping position.
- Spatial data entry and preparation.
- Spatial data analysis.
- Spatial data visualization.

Objectives
Main objective: To learn how to generate information about the Earth from data stored in Geographic Information Systems. At the end of this core module, participants must be able to:

Explain the principles and use the vocabulary of GIS:
- Describe the nature of geographic phenomena and their representation in the context of geo-informatics;
- Outline the principal data models for spatial and non-spatial data used in GIS databases;
- Outline the main components of a GIS and their functions;
- Explain the relationship between spatial data and coordinate systems;
- Outline the main spatial data analysis functions;
- Outline the principal rules for cartographic visualisation;
- Describe aspects of data quality and how various stages of spatial data handling affect it.

Carry out basic GIS operations:
- Carry out basic data preparation, geo-referencing and data entry into a GIS;
- Perform basic manipulation, analysis and visualisation operations using a GIS;
- Apply basic data quality assessment procedures.

Apply appropriate GIS methods for problem solving:
- Understand the capabilities, uses and limitations of GIS in their field of application;
- Design and carry out sequential data processing steps for solving a typical application problem;
- Evaluate the results of data processing;
- Be aware of organisational issues of GIS development and implementation.

Prerequisites
Not applicable.

Recommended Knowledge
Basic computer skills, basic mathematics.

Hardware and Software Requirements
ITC cluster PC with standard software and ArcGIS9.3.

Teaching Materials

Principles of Geographic Information Systems, 4th Edition, 2008. ITC Educational Textbook Series.
Principles of Geographic Information Systems, Exercises. Version 7.0, 2008.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
30	34	0	0	0	62	10

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Written closed book exam on the ITC GIS textbook referred to above.

Mathematics and Programming			
Module: 4		Co-ordinating staff: Prof. Dr.Ir. M.G. Vosselman	
Start:	01-12-2008		
End:	19-12-2008		
Level: M, MSc, PG			M08-GFM-163

Introduction

This module is designed to prepare the course participants for the domain specific part of the course. It will bridge the gap between the analytical knowledge base of the student from a wide range of diverse disciplines to the required appreciation for basic/universal mathematical concepts upon which the geoinformation technology is built. Furthermore it will include lectures and a larger assignment to further develop the programming skills.

Contents

Linear Algebra
- Vectors in 2D & 3D space
- Vector space
- Matrix operations
- Transformations(Linear, Projective, DLT)
- Eigenvalues and Eigenvectors

Calculus
- Differentiation
- Integration
- Partial Differentiation
- Implicit Differentiation
- Taylor and MacLaurin series for one or several variables and numerical applications

Programming
- See the separate description of Programming skills 1

Objectives

To introduce students to some of the mathematical principles which underline spatial application technology and tools. To equip students with adequate knowledge in programming language to construct simple spatial tools in existing geospatial applications.

Prerequisites

Modules 1 - 3.

Recommended Knowledge

Basic mathematics at BSc level.

Hardware and Software Requirements

Cluster with standard software. Python.

Teaching Materials

Lecture notes and slides, Python Tutorial.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
32	6	0	0	28	66	12

Time (in # of hours) allocated per major method:
- L lecture,
- SP supervised practical,
- UP unsupervised practical,
- GA group assignment (e.g. workshop, project),
- IA individual assignment (including Thesis, IFA),
- S self study,
- O overhead (e.g. QH, exam, opening)

Assessment
Two assessments with marks:
1. Programming skills: Individual programming assignment;
2. Mathematics: Written exam.

Programming skills 1			
Module: 1-4		Co-ordinating staff: Dr. O. Huisman	
Start:	29-09-2008		
End:	19-12-2008		
Level: M, MSc, PG			U08-GFM-159

Introduction

The main objective of this course component is to provide a working knowledge of programming in the Python programming language. Python is a General-purpose open-source computer programming language used by hundreds of thousands of developers around the world, in areas as diverse as spatial modelling, internet scripting, user interfaces, product customization, and more. Using a variety of theoretical and applied examples from each of the modules, students will learn how to think in a structured, logical way. "Programming Skills" will be taught and exercised in the first and second week of each module, but not in the exam week of any module. It will be assessed through regular exercises and project-based work.

Contents

- What is a program?
- The difference between interpreted scripts and compiled code.
- Variables, Expressions and Conditions.
- Functions.
- Recursive tasks.
- Working with Strings and Lists.

Objectives

After completing this course component students should be able to:

- Think analytically about a computational problem, i.e. be able to decompose and structure a problem,
- Formulate algorithms, which solve a given (simple) problem, and
- Implement these using Python.

Prerequisites

Not applicable.

Recommended Knowledge

Not applicable.

Hardware and Software Requirements

The Python programming environment, plus additional modules.

Teaching Materials

- The book How to Think Like a (Python) Programmer, Allen Downey, Green Tea Press, 2007.
- Lecture notes and slides available via Blackboard.
- Exercises and puzzles, distributed via Blackboard.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	24	0	0	0	12	12

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Students are required to submit completed exercises at the end of each module.
The mark allocated for this course component will make up a component of the overall mark for Module 4.

Master of Science and Postgraduate part

Principles of Spatial Data quality			
Module: 5		Co-ordinating staff: Dr. N. Hamm	
Start:	05-01-2009		
End:	23-01-2009		
Level: MSc, PG			M09-GFM-100

Introduction

This module aims to cover the basic principles of spatial data (SDQ). SDQ is mentioned in several modules throughout the MSc programme. This module will require students to give critical attention to the meaning of SDQ. It will also introduce students to the options available for storing information about SDQ. However, greatest attention will be given to quantitative and statistical aspects of the subject. To do this we will revise and develop some fundamental statistical concepts and computational tools which will be of more general value through the remainder of the MSc.

Contents

Introduction to SDQ
- Definitions of SDQ
- Key components of SDQ

Quantitative statistical analysis
- Basic concepts in probability and statistics
- Exploratory data analysis
- Regression and least squares
- Hypothesis testing and confidence intervals
- Attribute uncertainty
- Positional uncertainty

Modelling and uncertainty propagation
- Environmental modelling with spatial data
- Uncertainty propagation
- Validation of spatial data sets and model outputs

Objectives

At the end of the module students should have achieved the following learning objectives
- To be able to explain the term "spatial data quality" and use it appropriately.
- To be able to explain basic concepts in probability and statistics.
- To be able to implement basic exploratory data analysis in R.
- To be able to explain the principles of regression and least squares and implement them in R.
- To be able to outline the principles of non-linear least squares adjustment.
- To be able to define attribute and positional uncertainty and evaluate their impact on SDQ.
- To be able to able to describe the potential impacts of uncertainty on the quality of spatial data products.
- To be able to evaluate quantitatively the impact of uncertainty on the output of a simple model.

Prerequisites

Successful completion of ITC GFM modules 1 – 4.

Recommended Knowledge

An undergraduate module in statistics and data analysis.

Hardware and Software Requirements

Cluster with standard software. In addition to this we will use various freeware and open source software such as R and DUE.

Teaching Materials
Lectures will be used to introduce topics. There is a strong emphasis placed on private study – both for reading and for working through problems. Computer practical work will form an important part of the unit. Although there are no formal "group assignments", students will be encouraged to discuss the various issues with each other and we will use the Blackboard discussion forums to facilitate this.
Most materials will be made available via Blackboard. It must be emphasised that students will also be expected to use the library.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
30	36	0	0	0	38	16

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Throughout the module you will be provided with various short pieces of coursework. These will take the form of short-answer questions, problems sheets and computer practical assignments. These all need to be completed and submitted. They will be graded and will count towards your final grade for the module.

There will be a written examination at the end of the module. The written examination has the greatest weight for determining your grade at the end of the module.

Base Data Acquisition			
Module: 6		Co-ordinating staff: Dr. K. Tempfli	
Start:	26-01-2009		
End:	13-02-2009		
Level: MSc, PG			M09-GFM-101

Introduction

The acquisition of data that can constitute the basis of a Spatial Data Infrastructure (SDI) is subject of this module with a focus on current production technology. The purpose of achieving a good understanding of presently applied concepts and used systems and gaining awareness of trends in data acquisition technology is strengthening the fundament for doing research in geoinformatics.

Contents

The main groups of subject are:

- Digital aerial cameras and very high resolution satellite sensor systems for base mapping;
- Direct and indirect sensor orientation;
- Digital terrain modelling;
- Digital orthoimage production;
- Conventional feature extraction from images for topographic databases;
- Standards and specifications for base mapping.

Objectives

Upon completion of this module students should be able to:

- Explain the standard processes of generating and updating base data, specifically topographic data for large and medium scale mapping;
- Describe the problems of current concepts and systems and explain the expected impact of new geospatial data acquisition technologies;
- Interpret standards and specifications; explain and apply quality control procedures.

Prerequisites

Modules 1 to 5 of the GFM course.

Recommended Knowledge

Core concepts of remote sensing and topographic mapping, linear algebra and coordinate transformations, calculus, basic statistics, parameter estimation.

Hardware and Software Requirements

Computer Cluster(s): ERDAS IMAGINE, Leica Photogrammetry Suite (LPS), SURFER.

Teaching Materials

Hardcopy hand-out containing reading material, a B&W copy of the lecture slides, and practical assignment instructions; PDF's of the lecture slides in Blackboard. Images and data for the practicals.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
32	22	0	0	0	40	20

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Written examination 80%, course work 20%.

Geodata modelling and processing			
Module: 7		Co-ordinating staff: Dr. J. Morales	
Start:	16-02-2009		
End:	06-03-2009		
Level: MSc, PG			M09-GFM-102

Introduction
Managing large quantities of structured and unstructured (spatial) data is a primary function of information systems. Data models describe structured data for storage in data management systems such as relational databases. Data models also define constraints or limitations on the data placed within the structure.
Process models allow the definition of series of analytical (spatial) operations that can be applied to structured and unstructured data. Open standards play a significant role in the manipulation and sharing of (spatial) data, Open standards are publicly available specifications that provide a common method of achieve particular goals, among those the definition of shareable (spatial) data and processing models.

Contents
This module focuses on the techniques that support the process of creating conceptual data and process models by applying a model theory.

The topics covered by the module include:
- Methods of conceptual design and specification of information systems;
- Spatial operators and operations;
- Multiscale databases;
- Open standards.

Objectives
Upon completion of this module students should be able to:
- Explain and apply the fundamental concepts of object-orientation;
- Use a data model to describe the structure of the data within a given application domain;
- Derive and analyse user requirements for an application;
- Create and automate (spatial) processing tasks;
- Apply the principles of cartographic generalization for the definition of multiscale data representations;
- Apply open standards in the execution of any of the above mentioned tasks.

Prerequisites
ITC core modules.

Recommended Knowledge
Basic computer handling.

Hardware and Software Requirements
Not applicable.

Teaching Materials
Literature handouts and overhead sheet copies.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
36	46	0	0	0	44	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

The module will be assessed by means of a written examination. This will be a closed book examination. In the event of practical work which results is an individual reports, weighting of 50% practical work and 50% examination will be applied for the determination of the mark.

Visualization and dissemination of geodata			
Module: 8		Co-ordinating staff: Ms. Dr. C.A. Blok	
Start:	09-03-2009		
End:	27-03-2009		
Level: MSc, PG			M09-GFM-103

Introduction
Earlier course modules have dealt with (amongst others) the acquisition of various kinds of geodata, their structuring, modelling and analysis in geographic information systems. Visualization and dissemination of geodata, for goals varying from exploration, analysis, synthesis, and presentation, and to provide (Web) access to maps, information and data are also important aspects of geodata and geoinformation use. Therefore, the module Visualization of Geodata can be considered as one of the fundamental building blocks of the GFM MSc course.

Contents
As a follow-up to the brief introduction to visualization of geodata in the Core Modules, this module provides the main principles of visualization of geodata in a GIS- and/or Web-environment. It also provides an introduction to the dissemination of (visualized) geodata.

Main subjects are:
Visualization of geodata:
- Design aspects to map topographic and thematic data;
- Geometric aspects of mapping and multiscale problems in a GIS-context (map projections, scale, cartographic generalisation);
- Visual exploration.

Dissemination and use of (visualized) geodata:
- Data products, use and users of products;
- Dissemination methods and environments, with emphasis on the World Wide Web.

Objectives
Upon completion of this module students should be able to:

Understand and explain:
- the roles of visualization in geodata handling in a GIS and/or Web environment;
- how use and users tailor visualization design decisions;
- cartographic design principles to map topography and themes;
- the concept of scale and the relation between scale distortions and characteristics of map projection systems;
- the need for, and basic principles of, cartographic generalisation in multiscale representations of geodata;
- the basic concepts related to 3D, dynamic and interactive geodata visualization;
- various dissemination methods and environments, and their role in geodata provision for different kinds of use and users.

Apply:
cartographic visualization principles to different kinds of visualizations of geodata, and judge the appropriateness of their application, taking data characteristics and use issues into account.

Prerequisites
Modules 1 - 7 of the GFM Course.

Recommended Knowledge
Not applicable.

Hardware and Software Requirements
PC's with ArcGIS 9.x, Internet access.

Teaching Materials
Kraak, M. J. and F. J. Ormeling (2003). Cartography, Visualization of geospatial data. Harlow: Pearson Education and a Reader.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
28	24	0	10	0	44	24

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
- Individual assessment based on a written test (closed book examination, partly structured and partly with short open questions) – counts for 80% in the module result.
- Assessment of the results of a group task: review of a series of maps, submission of improved designs and presentation of the results – counts for 20% in the module result.

Image processing			
Module: 9		Co-ordinating staff: Dr. V.A. Tolpekin	
Start:	30-03-2009		
End:	17-04-2009		
Level: MSc, PG			M09-GFM-104

Introduction
Conventional image processing methods, as taught in the core modules, may not produce optimal results for all data types or all applications. In this module those limitations are identified and discussed, and alternative methods and approaches are introduced. Those are advanced image classification, image segmentation, matching and fusion. Related to those methods this course will address fuzzy vs. crisp approaches, classification uncertainty and errors and the use of texture and pattern in contextual classification. Application of the image processing methods in the field of geoinformatics is demonstrated.

Contents
- Image segmentation techniques;
- Image classification techniques (subpixel, fuzzy, expert, object-oriented classifiers);
- Image matching (area based, feature based);
- Image fusion (pan sharpening).

Objectives
Upon completion of this module students should be able to:
- Explain image processing methods, as well as their respective advantages and disadvantages, and make informed decision on which (combination of) method(s) is suitable for a given problem set or image type.
- Apply these methods to case studies using available software and data.

Prerequisites
Core modules, previous domain-specific modules.

Recommended Knowledge
Not applicable.

Hardware and Software Requirements
ERDAS Imagine, IDL ENVI, R

Teaching Materials
Handouts of lectures, exercise descriptions, software tutorials, papers (to be specified later), websites. Image data (multispectral images).

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
32	18	0	0	0	36	5

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Individual assessment, mark based on practical exercises and final exam.

Web technology for GIS and mapping			
Module: 10		Co-ordinating staff: Ir. R.L.G. Lemmens	
Start:	20-04-2009		
End:	08-05-2009		
Level: MSc, PG			M09-GFM-105

Introduction
Web technology becomes increasingly powerful and applicable to geo-information handling. Internet applications are nowadays commonly used in combination with traditional GIS to disseminate geo-information within and outside organisations. A basic understanding of some essential technologies suffices to build simple yet versatile web gis applications.

Contents
This module focuses on the techniques needed to communicate data through the internet. Students will be introduced to general computer networking theories and internet concepts and they are offered an introduction to several tools, with which internet applications can be built. Throughout the course special attention will be given to the implementation of spatial data communication in GIS and mapping environments over the Internet, often referred to as Internet GIS and mapping applications.

The topics covered by the module include:
- Computer networks: Principles of computer networks, hardware/software, client/server computing.
- Internet concepts: Overview of Internet concepts & features: Internet protocol, Domain Name System, Internet services, WWW, Web servers, Web clients.
- Web application development: Web page design principles, HTML, introduction to XML, data formats, helper applications, Java, databases and the Web.
- Internet GIS: Application of Internet services to GIS, Internet GIS software, interoperability issues & OpenGIS.

Objectives
Upon completion of this module students should be able to:
- Explain the basic principles of Internet components such as Web clients, Web servers and protocols that form the basis for simple and advanced Internet applications;
- Distinguish the characteristics between typical Internet programming tools and position them in specific applications;
- Discover geo-datasets on the Internet and use them in GIS applications;
- Apply Web design principles and basic programming techniques to develop an interactive website with functionality relevant for database access, GIS and Web mapping.

Prerequisites
ITC core modules.

Recommended Knowledge
Basic computer handling.

Hardware and Software Requirements
Web browser, Macromedia Dreamweaver, PostGIS, University of Minnesota MapServer.

Teaching Materials
Literature handouts and overhead sheet copies.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
18	30	0	0	20	68	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

All four subjects as being taught through lectures as well as practicals and assignment will be examined by means of a written examination of 2 hours duration. This will be a closed book examination. In addition the practical work which results is an individual web site will be assessed by the supervisors.

For the mark a weighting of 50% practical work and 50% examination will be applied.

Programming skills 2			
Module: 5-10		Co-ordinating staff: Dr. O. Huisman	
Start:	05-01-2009		
End:	08-05-2009		
Level: MSc, PG			U09-GFM-134

Introduction

The main objective of this course component is to provide a working knowledge of programming in the Python programming language. Python is a General-purpose open-source computer programming language used by thousands of developers around the world, in areas as diverse as spatial modelling, internet scripting, user interfaces, product customization, and more. Using a variety of theoretical and applied examples from each of the modules, students will learn how to think in a structured, logical way. "Programming Skills" will be taught and exercised in the first and second week of each module, but not in the exam week of any module. It will be assessed through regular exercises, fitting with the mode of delivery.

Contents

- solving equations with matrices
- plotting graphs
- image processing with PIL
- processing hyperspectral data
- database connectivity with Python
- accessing data via the web
- accessing WMS and WMF
- geoprocessing using ArcGIS
- and more…

Objectives

After completing this course component students should be able to:

- Think analytically about a computational problem;
- Formulate algorithms, which solve a given (simple) problem;
- Create computational solutions for a given problem using Python;
- Apply object-oriented techniques to model spatial phenomena;
- Provide computational functionalities via the Web.

Prerequisites

Programming skills 1.

Recommended Knowledge

Basic programming.

Hardware and Software Requirements

The Python programming environment, plus additional modules.

Teaching Materials

- The book How to Think Like a (Python) Programmer, Allen Downey, Green Tea Press, 2007.
- Lecture notes and slides, available via Blackboard.
- Exercises and puzzles, distributed via Blackboard.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
12	24	0	0	0	12	12

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

Students are required to submit completed exercises at the end of each module. The mark allocated for this course component will make up a component of the mark for Module 10.

Postgraduate Diploma part

Final assignment			
Module: 11		Co-ordinating staff: Dr. M. Rutzinger	
Start:	18-05-2009		
End:	05-06-2009		
Level: PG			M09-GFM-128

Introduction
The final assignment is an integral part of the Geoinformatics Post-Graduate Diploma course. The Final Assignment focuses on the application of knowledge, methods and techniques in Geoinformation acquired throughout the course. The Final Assignment will be performed individually, but part of the assignment could be performed in groups. Participants will receive information from staff about the content of proposal topics. The output of the assignment will be a final report which will be presented and discussed in public.

Contents
The project is related to one or more of the following items:
- Data acquisition quality;
- Geodata modelling;
- Visualization;
- Image processing;
- Web technology.

Objectives
Upon completion of this module students should be able to:
- Plan and execute a small project assignment dealing with a practical application of GIS and RS tools to a problem encountered in the professional practice of geoinformation.
- Independently apply the knowledge and skills in GIS and RS data structuring, processing and analysis that have been taught in the GFM course.
- Review and reflect upon the knowledge and skills learned throughout the taught part of the course.
- Prepare a concise report.
- Present and defend the final assignment orally.

Prerequisites
Successful completion of the modules 1-10 of the Geoinformatics course.

Recommended Knowledge
Not applicable.

Hardware and Software Requirements
Personal Computer, ArcGIS, ILWIS and Erdas software.

Teaching Materials
Not applicable.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
0	0	0	0	144	0	10

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Individual assessment based on the final report and the presentation of the report in public.

Master of Science research part

MSc Research Skills			
Module: 11		Co-ordinating staff: Dr. D.G. Rossiter	
Start:	18-05-2009		
End:	05-06-2009		
Level: MSc			P09-EDU-100

Introduction

The ITC MSc thesis research phase aims to strengthen your ability to execute scientific research. The success of your thesis research depends, apart from skills and conceptual background in your scientific discipline, also on the ability to adequately structure your thesis. This module provides a set of generic research skills applicable to all MSc students at ITC to improve performance in the subsequent thesis research. The module teaches you why research is structured as it is and challenges you to develop the ability to critically review scientific work of yourself and others. You will be trained to analyze the structure, logic and quality of research with examples from your own scientific field. Also you will develop skills to structure scientific research. The module finally aims to create common understanding of what is expected of a thesis and how it will be assessed, to allow you to comply with these expectations.

Contents

- Logic and structure of scientific research.
- Inference in various scientific disciplines.
- Literature search, citation and bibliography.
- Abstracting and reviewing scientific research.
- Scientific writing and argumentation.
- Research quality and thesis assessment.
- How to structure an MSc thesis.
- Ethics and professionalism in research.

Objectives

Upon completion of the module, participants will be able to:

- understand why scientific research is structured as it is,
- recognize and critically assess research quality,
- present scientific research at a standard acceptable to the scientific community,
- find, evaluate, and summarize the most relevant and up-to-date scientific literature to support research, and
- structure an MSc thesis research according to academic expectations.

Prerequisites

Before entering module 11 participants have to submit their intended line of research (MSc pre-proposal), based on the available MSc projects presented at the MSc fair (March 11). This includes: choice of topic and rationale, choice of module 12, 13 and 14-15, available datasets, (optional) fieldwork planning and envisaged MSc supervisors.

At the start of module 11 participants must be able to:

- Present and discuss research in public;
- Communicate about technical subjects in written English;
- Understand the importance of innovation, quality and independent thinking in science.

Besides participants are expected to have:

- A background in at least one relevant scientific field;
- A critical/creative attitude.

Prerequisites

Not applicable.

Staff involved
Dr. P.M. van Dijk, Director Graduate Programme
Dr. D.G. Rossiter, overall coordinator module 11

Delegate coordinators per course:
Dr. N. Kerle (AES)
Dr. J.E. Stoter (GFM)
Drs. J.C. de Meijere (GSIM)
Ir. W.T. de Vries (LA)
Dr. J. de Leeuw (NRM)
Dr. R.V. Sliuzas (UPM)
Dr. A.S.M. Gieske (WREM)

other departmental staff and supporting staff (Library, RC, IT)

Hardware and Software Requirements
Networked PCs, Word, End note and access to scientific bibliographic databases.

Teaching Materials
Digital presentations, description of assignments, reader, scientific articles and MSc theses for review.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
31	4	0	0	0	98	11

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment

(1) Full participation in (group)discussions is expected;

(2) Further, the mark is derived from four written assignments:

1. Literature skills: (i) Finding relevant literature from specified information resources, (ii) entering references to these in a bibliographic database, (iii) organizing the main points into a coherent paragraph, and (iv) formatting a reference list from the bibliographic database;
2. Summarizing and abstracting an important scientific paper in the research field of your course;
3. Assessing a published thesis from your course according to ITC criteria;
4. Arguing a scientific position in correct, compact and direct structured technical English.

Advanced topics 12 & 13			
Module: 12 & 13		Overall Co-ordinating staff: Dr. P.M. van Dijk	
Start:	08-06-2009		
End:	17-07-2009		
Level: MSc			P09-EDU-101/102

Introduction

Modules 12 and 13 form the backbone of the third Block of the MSc programme. Following module 11 on research skills and before the engagement in research themes during modules 14-15, students are equipped with advanced subjects for their research. During modules 12 and 13 students will learn in depth about specific research tools, methodologies and applications that are important for their envisaged MSc research. Participants have to make a logical choice that fits with their envisaged MSc research during Block 4 (MSc research phase; modules 16-23). The choice is made and explained in the MSc pre-proposal that has to be submitted after the MSc fair (March 12th 2008) and before the start of module 11 (exact date and format to be specified).

The final list of choice for the 2008/09 courses will be available by January 2009, after evaluation of the 2007/08 courses and final approval by the Academic Board. The subjects may be updated/changed, new subjects may be added and some may be deleted.

In this generic study guide description the 24 advanced subjects of the 2007/08 course are mentioned to show the range of subjects. Their descriptions can be viewed in the "Search module descriptions" option on internet: http://www.itc.nl/education/courses/modules.aspx , select studyguide = 2007-2008, level = MSc and module = 12, respectively 13.

Contents

Module 12:	Title	Chair	Module Coordinator
M09-EOS-100	Advanced image analysis	Prof. A. Stein	Dr. V.A. Tolpekin
M09-GIP-100	Design and Implementation of Spatial Databases	Prof. M.J. Kraak	Dr. R.A. de By
M09-ESA-100	Essentials of physical process modelling	Prof. V.G. Jetten	Prof. V.G. Jetten
M09-EOS-101	Geostatistics	Prof. A. Stein	Dr. D.G. Rossiter
M09-ESA-101	Hyperspectral Remote Sensing	Prof. F.D. van der Meer	Dr. H.M.A. van der Werff
M09-EOS-102	Inferential statistics	Prof. A. Stein	Dr. J. de Leeuw
M09-EOS-103	Laser scanning and InSAR	Prof. M.G. Vosselman	Prof. M.G. Vosselman
M09-PGM-100	Managing geoinformation systems in the public sector	Dr. C.M.J. Paresi	Dr. D.D. Navarra
M09-NRS-100	SAR Remote Sensing	Prof. A.K. Skidmore	Dr. Y.A. Hussin
M09-PGM-101	Spatial growth and spatial interaction modelling	Dr. R.V. Sliuzas	Dr. M.H.P. Zuidgeest
M09-PGM-102	Spatial planning support systems and scenario development	Dr. C.M.J. Paresi	Dr. M.A. Sharifi
M09-PGM-103	Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA) applying Spatial Decision Support tools	Prof. A. van der Veen	Drs. J.M. Looijen
M09-GIP-101	Time series	Prof. M.J. Kraak	Prof. M.J. Kraak

Module 13:	Title	Chair	Module Coordinator
M09-EOS-104	3D Geoinformation	Prof. M.G. Vosselman	Dr. M. Gerke
M09-EOS-105	Advanced statistics	Prof. A. Stein	Prof. A. Stein
M09-PGM-104	Applying research methods for public sector geoinformation management	Dr. C.M.J. Paresi	Dr. D.D. Navarra
M09-GIP-102	Design and implementation of Geoinformation Services for SDI	Prof. M.J. Kraak	Ir. R.L.G. Lemmens
M09-ESA-102	Geophysics and 3D geo-visualization of the subsurface	Prof. F.D. van der Meer	Dr. M. van der Meijde
M09-ESA-103	Integrated Risk Assessment	Prof. V.G. Jetten	Dr. C.J. van Westen
M09-WRS-100	Large scale process modelling and data Assimilation	Prof. Z. Su	Prof. Z. Su
M09-PGM-105	Participatory GIS – principles and applications	Dr. R.V. Sliuzas	Dr. M.K. McCall
M09-WRS-101	Quantitative retrieval of geo(bio)physical parameters	Prof. W. Verhoef	Prof. W. Verhoef
M09-PGM-106	Scenario analysis and collaborative decision support	Dr. C.M.J. Paresi	Dr. M.A. Sharifi
M09-NRS-101	Spatial modelling of biological Ecosystem Properties	Prof. A.K. Skidmore	Dr. P.E. van Laake

Objectives
Specified per advanced subject.

Prerequisites
MSc modules 1-11 (and other specifications as given per subject).

Recommended Knowledge
Specified per advanced subject.

Staff involved
Appointed per advanced subject.

Hardware and Software Requirements
Specified per advanced subject.

Teaching Materials
For each advanced subject a collection of resources will be available in the digital learning environment Blackboard, the library or in hard copy.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
16	20	0	30	30	40	8

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
Specified per advanced module, the assessment must result in a mark.

Research Themes / MSc Qualifier			
Module: 14 & 15		Overall Co-ordinating staff: • Dr. P.M. (Paul) van Dijk • Research project coordinators appointed per research theme • 2 MSc supervisors appointed beforehand for each participant	
Start:	08-06-2009		
End:	17-07-2009		
Level: MSc			P09-EDU-103

Introduction

Modules 14 and 15 form the last part of Block 3 of the MSc programme. While Modules 11 to 13 have instrumented the students with research methods and tools, the last two modules focus on the research themes of ITC. These themes form the subject framework and organizational structure in which MSc students conduct their individual MSc research in Block 4 of the MSc programme (modules 16-23). At the end of Module 15, a Thesis Admission Committee decides whether a student is admitted to Block 4.

Each ITC research theme offers one or more projects for Module 14 and 15, where possible together with one or more other themes. The general structure is the same; the content will be theme specific, and where possible inter-disciplinary. Research themes are free to fill this in within the boundaries described in this module description.

The purpose of Modules 14 and 15 is to deepen the knowledge and skills of students within the research theme and to help students to define their own MSc research proposal.

The student has to make a choice for a certain research theme, based on his/her envisaged MSc thesis topic. The following 15 themes are available:

Education Unit 14 / 15:	Title Research theme	Research theme leader
U09-NRS-101	Biodiversity in fragmenting landscape	Prof. A.K. Skidmore
U09-NRS-102	Carbon-cycle and climate change	Prof. A. de Gier
U09-ESA-100	Disaster management	Prof. V.G. Jetten
U09-ESA-101	Earth systems science	Prof. F.D. van der Meer
U09-NRS-103	Food security and environmental sustainability	Prof. E.M.A. Smaling
U09-PGM-100	Governance and Integrated Spatial Assessment	Prof. A. van der Veen
U09-PGM-101	Informed multilevel governance of urban regions	Prof. Y. Georgiadou
U09-PGM-102	Land administration for informed governance	Prof. J. Zevenbergen, Prof. P. van der Molen
U09-WRS-100	Managing water scarcity	Dr. M. Lubczynski
U09-GIP-100	Spatial data infrastructure technology	Dr. R.A. de By
U09-GIP-101	Spatio-temporal data integration and visualization	Prof. M.J. Kraak
U09-PGM-103	Sustainable urban-regional dynamics	Prof. F.A.M. van Maarseveen
U09-EOS-100	Stochastic methods for image mining and data quality	Prof. A. Stein
U09-EOS-101	Utilisation of sensor developments for efficient topographic mapping	Prof. M.G. Vosselman
U09-WRS-101	Water cycle climate	Prof. Z. Su, Prof. W. Verhoef

For more information about the content and scope of the ITC research themes, please visit: http://www.itc.nl/research/themes.asp

Contents
Two main activities run parallel in Module 14 and 15:
1. Finalizing the research proposal for the individual MSc thesis.
2. A group research project.

1. Finalizing the research proposal
The MSc research proposal is finalized by the student in mutual agreement with his/her MSc supervisors, appointed in Module 11. The research proposal should be a logical and ordered exposition of the envisaged research (as introduced in Module 11), including data availability, (fieldwork) methodology, a flowchart, and time allocation. All data should be available at the time of the proposal presentation. The research proposal should be presented before a Thesis Admission Committee (see MSc assessment regulations paragraph 5.1.1). Acceptance of the proposal is a prerequisite for the start of module 16. The MSc student will draft a supervision plan with the two appointed MSc supervisors.

2. Group research project
The purpose of the group project is:
- To let students place their own MSc research project and research interests in a wider scientific context.
- To give students a possibility to practice conducting a research project before their individual MSc research project.
- To give students an opportunity to practice doing research in a team.
- To give students the opportunity to share their knowledge in a multi-disciplinary context.

These are considered important as a preparation for conducting the individual MSc research in Block 4, as well as the professional academic working practice afterwards in which projects are often conducted in multi-disciplinary groups.

Research projects can be defined by one or several research themes. In any case, the projects are defined with a wide angle in order to cater for a variety of research approaches and interests, as well as the relevance for society. Projects are described with a title, a problem definition, and available dataset. The student group, consisting of a maximum of 5 students, is responsible for working this out into various activities according to an agreed plan. The student group has the freedom to make their own choices, supported by a tutor. The available projects will be made known early in 2009 in order to give the participants the opportunity to select a project that matches with their research interest. The choice has to be submitted before the start of module 11 (exact date to be specified) and should be justified within the MSc pre-proposal.

In a plenary session at the start of module 14, the Principal Investigator of the research group will introduce the various MSc subjects and their interrelation in the framework of the research of his/her group, and introduce the research assignments. A tutor will be appointed during module 14-15 to guide the students groups. The tutors will convene plenary sessions (in principle per research group) to monitor the progress of all participating students and exchange experiences in a discussion forum.

Objectives
Upon completion of these modules students will be able to:
1. Write an MSc research proposal.
2. Define ways how to tackle a scientific problem and structure research.
3. Place research projects in a wider scientific and societal context.
4. Structure scientific research to specifications of the scientific discipline.
5. Meet quality standards and excellence in research.
6. Present scientific information in written English at a standard acceptable to the scientific community.

Prerequisites
Completion of Module 1 to 13 of the MSc curriculum.
Because the research themes will be taught at advanced level, it is necessary to have a basic level of knowledge in the chosen research theme. Students who want to choose a research theme which differs from their choice in Block 1 and 2, have to provide evidence that they have the right background.

Recommended Knowledge
To be specified per research theme.

Staff involved
Overall coordination: Dr. P.M. van Dijk, Director Graduate programme:
- Research project coordinators appointed per research theme;
- 2 MSc supervisors appointed beforehand for each participant.

Hardware and Software Requirements
Identified per research theme.

Teaching Materials
For each research theme a collection of resources will be available in the digital learning environment Blackboard, the library or in hard copy.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
10	0	0	70	(120)	16 (+32)	(40)

Time (in # of hours) allocated per major method:
L lectures, (max. 10 = 5 hr/week during 2 weeks of project)
SP supervised practical,
UP unsupervised practical,
GA group assignment (= Group Research Project, incl. supervision),
IA individual assignment (= MSc proposal writing, incl. supervision),
S self study (8hr/week = 48 hr outside normal class/office hours),
O overhead (last week reserved for MSc proposal presentations).

Important:
The numbers are calculated for **two** modules: 96 hr (= 2 weeks) are allocated for the group research project, and 192 hrs (= 4 weeks) are reserved for the MSc proposal (=numbers between brackets).

Assessment
1. Group report of the research project.
2. Individual written reflection report on the group research project.
3. Individual MSc research proposal (written and oral presentation).

MSc Research and Thesis Writing			
Module: 16-23		Co-ordinating staff: Dr. P.M. van Dijk, Director Graduate Programme Course directors of all MSc courses 2 MSc supervisors per student	
Start:	07-09-2009		
End:	26-02-2010		
Level: MSC		AES, GFM, GSIM, LA, NRM, UPM, WREM	U09-EDU-111

Introduction
The final stage of the MSc course is dedicated to the execution of an individual research project. Each student works independently on an approved research topic (see module 15) connected to one of the 15 research themes of ITC. In the project the students develop their research skills further, interact with their fellow students, PhD's and staff members, and have to demonstrate that they have achieved the course objectives for the Master of Science degree by research, on academic level.

Contents
Based on the pre-proposal handed in before module 11, and the final accepted research proposal prepared in module 15, the student will carry out the planned activities. The students will be provided with guidelines for the thesis early in the course (specifically in module 11). Regular individual progress meetings with the supervisors will be held to monitor the progress on the research and thesis writing, and records of the progress will be kept. The supervisors keep the course director informed about the progress.

The activities normally include:
- Describe and define a problem statement and research topic and its research margins.
- In-depth literature review, including assessment of the usability of literature and previous research.
- Collection of relevant on-line and archived data.
- Preparation and execution of a (data collection) fieldwork (optional).
- Data processing and analysis and, if deemed necessary, adjustment of the research plan in consultation with the supervisors (based on sound arguments).
- Active participation in Institute seminars and *capita selecta* of the research theme under which the MSc research resorts.
- Mid-term presentation (first week of November).
- Preparation of the final manuscript of the MSc thesis (=hardcopy thesis and CD-rom with thesis, appendices and full dataset including original data and results).
- A critical review of quality, use and usefulness of the data and results, as well as the learning process.
- Oral presentation and defence of the MSc thesis before the Thesis Assessment Board, all in accordance with the relevant paragraphs of the MSc regulations.

Objectives
The student must be able to:
- Define, plan and execute a research project dealing with a problem related to the application of geo-information and earth observation in a domain that suits his/her background and course followed.
- Write a concise, logical and well structured thesis describing the key elements of the research process, the findings and recommendations.
- Orally present and defend the work done before the Thesis Assessment Board.

Prerequisites
Successful completion of MSc modules 1-15, and the ability to do research independently (ref. to par. 5.3.1. of the MSc regulations).

Recommended Knowledge
During the research phase, the students can specialise further in their own field of expertise.

Hardware and Software Requirements
Any hardware and software with authorisation of the MSc supervisors.

Allocated Time per Teaching Learning Method

L	SP	UP	GA	IA	S	O
0	0	0	0	1136	0	16

Time (in # of hours) allocated per major method:
L lecture,
SP supervised practical,
UP unsupervised practical,
GA group assignment (e.g. workshop, project),
IA individual assignment (including Thesis, IFA),
S self study,
O overhead (e.g. QH, exam, opening)

Assessment
A Thesis Assessment Board (TAB) will carry out the individual assessment based on the thesis and a presentation plus defence. The assessed aspects are:
- Research skills;
- Contribution to the development of the scientific field;
- Independent working;
- Critical and professional thinking;
- Scientific report writing;
- Presentation and defence.

For further details on the regulations and thesis assessment, see:
- ITC Regulations for courses leading to an ITC Master of Science (M.Sc.) Degree (September 2008);
- Instructions for Thesis Assessment Board.